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Kikuchi et al.

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(54) **ELECTRONIC DEVICE**

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(51) **Int. Cl.**
H01H 5/30 (2006.01)

(52) **U.S. Cl.** **200/406**; 200/516

(58) **Field of Classification Search** 200/406, 200/516, 520, 533–535, 551, 341
See application file for complete search history.

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(74) *Attorney, Agent, or Firm* — Whitham, Curtis, Christofferson & Cook, PC

(57) **ABSTRACT**

A switch-type electronic device adapted to be mounted on a circuit board is disclosed. A housing is made of an insulative material. The housing includes a first face adapted to oppose the circuit board and a second face intersecting with the first face and formed with a projection. A cover is made of a conductive material. The cover includes a first part covering a side of the housing opposite to the first face, at least one second part extending from the first part and opposing the second face, and a third part extending from each of the at least one second part and engaging with the projection. An operating member includes a first part disposed outside the housing and adapted to be operated by a user, and a second part disposed in the housing and configured to switch the electronic device between a first state and a second state when the first part is operated by the user. The first part of the operating member includes a portion opposing the second part of the cover, and is configured to abut against the second part of the cover when the electronic device is switched between the first state and the second state.

6 Claims, 10 Drawing Sheets

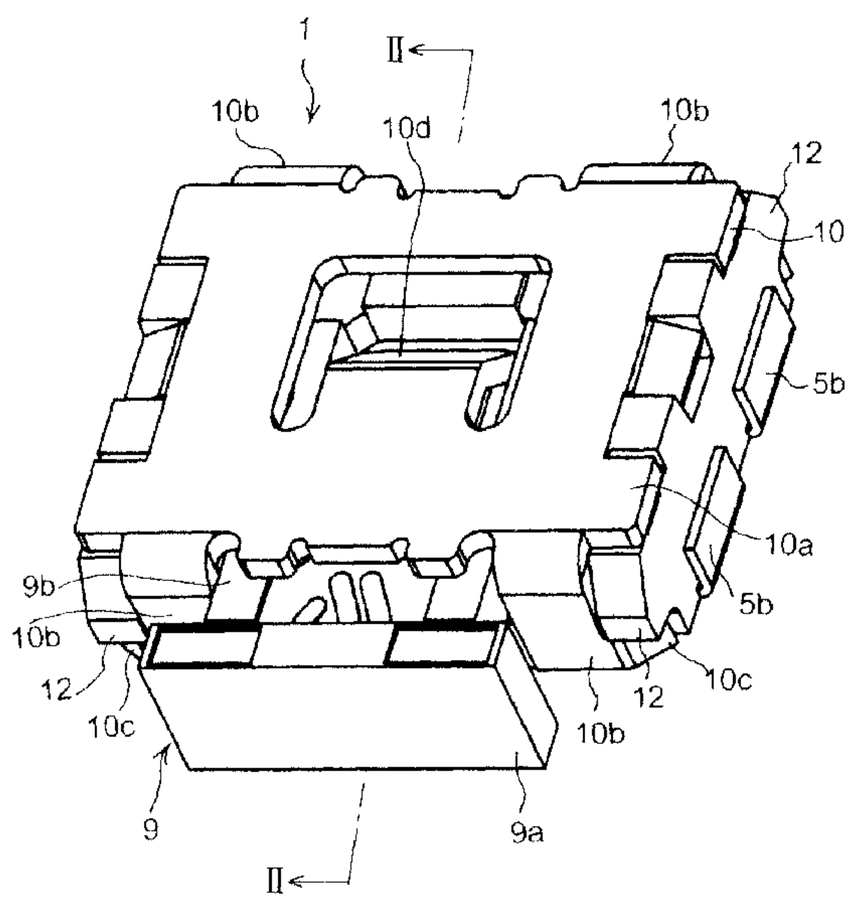
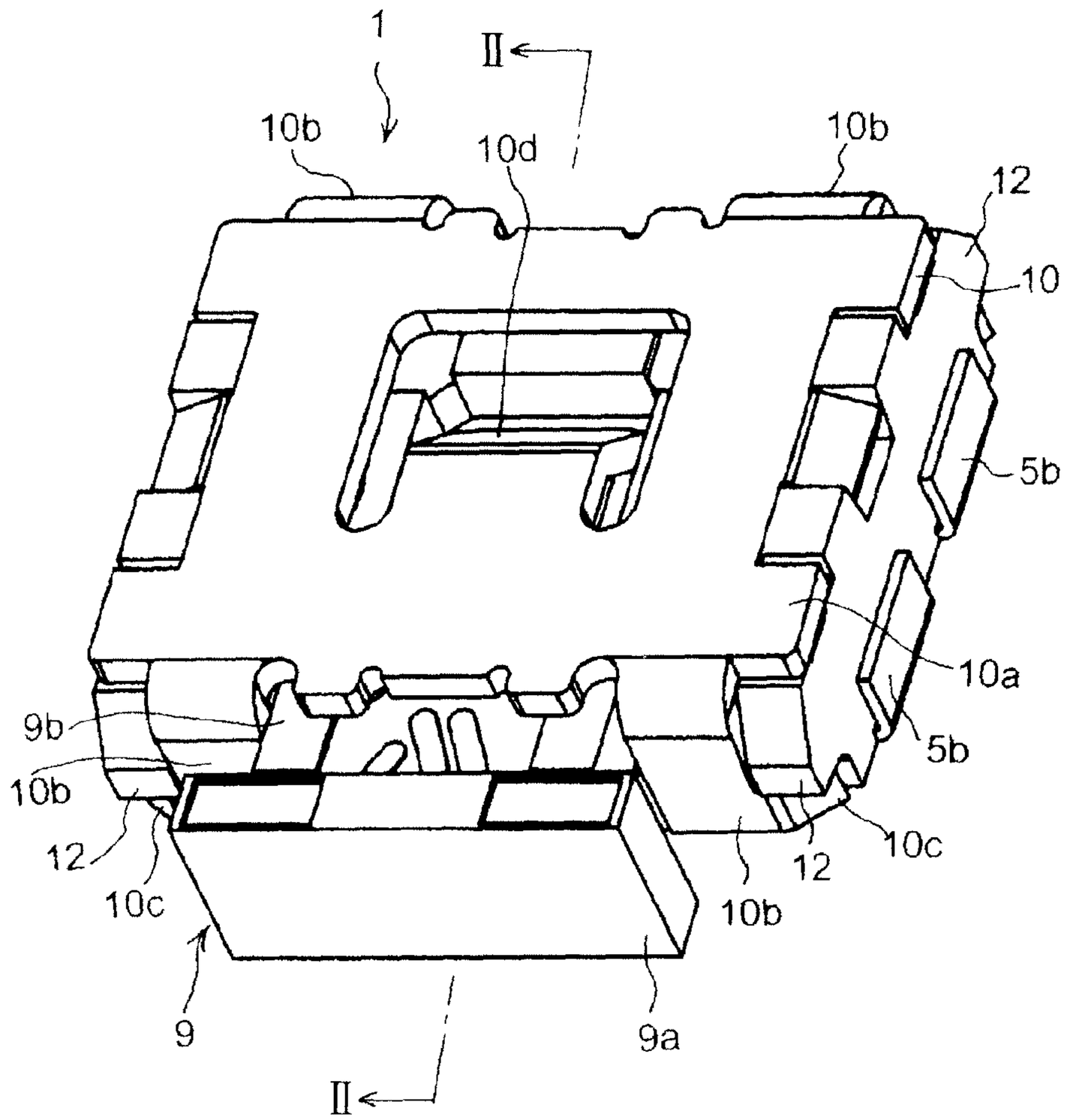


FIG. 1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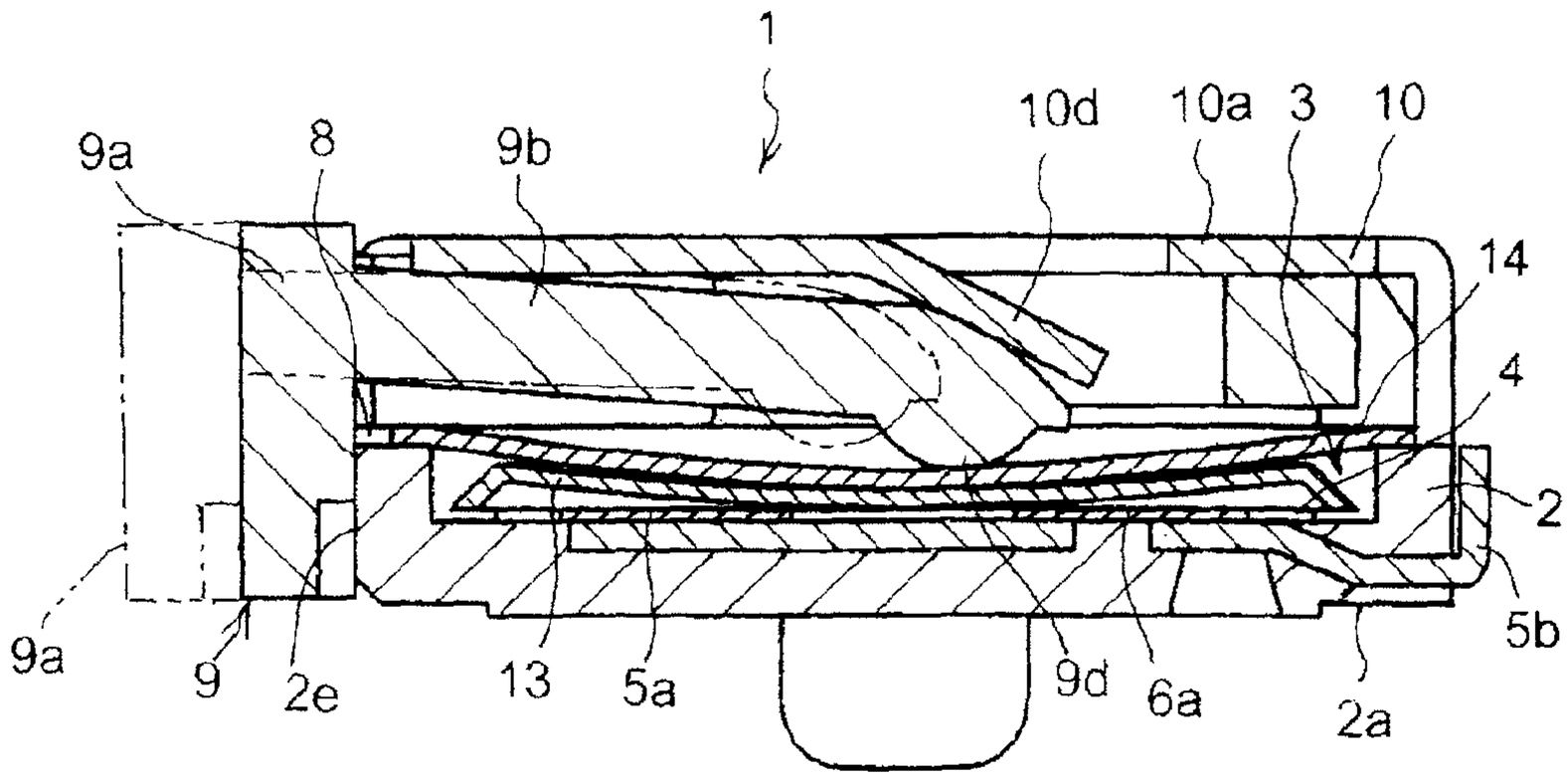
10d
10b
12
10
5b
10a
5b
9b
10b
12
10c
12
10c
10b
9
9a
II

FIG. 2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8
9b
10d
10a
3
10
14
4
2
5b
9a
9
2e
13
5a
9d
6a
2a

FIG. 3

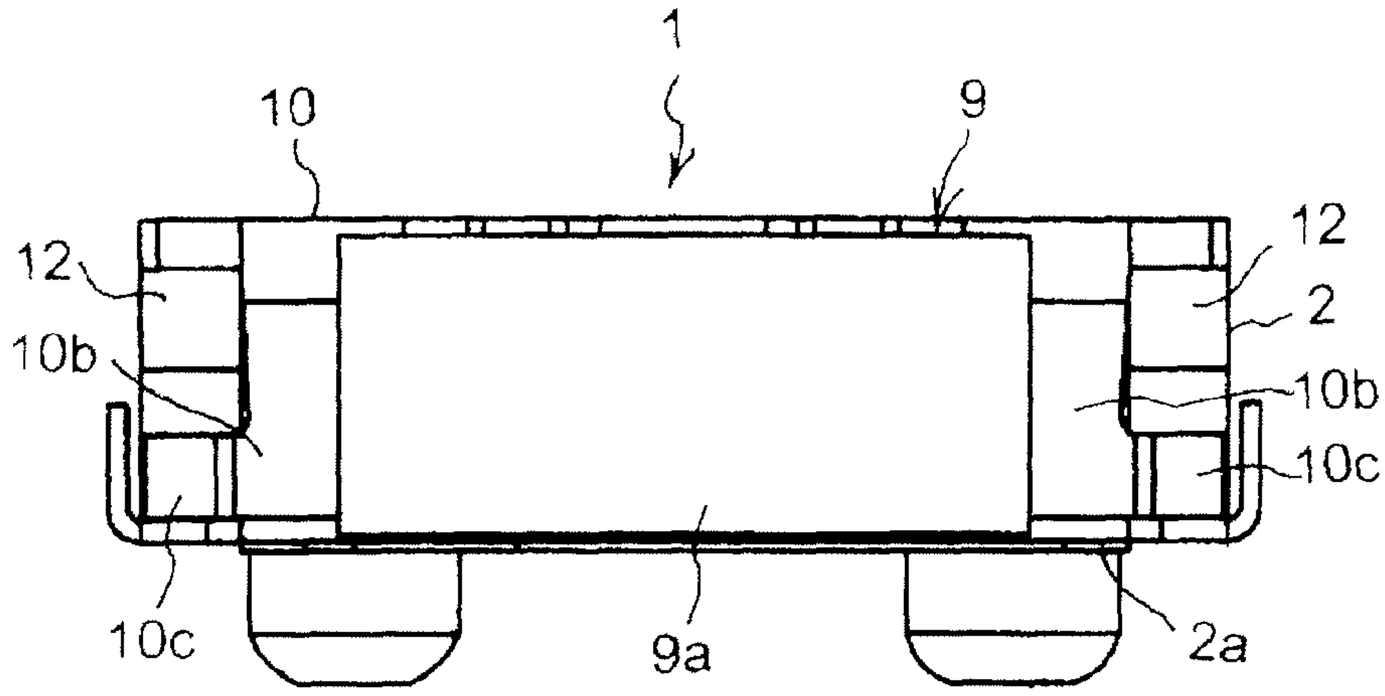

1
10
9
12
10b
12
2
10b
10c
10c
9a
2a

FIG. 4

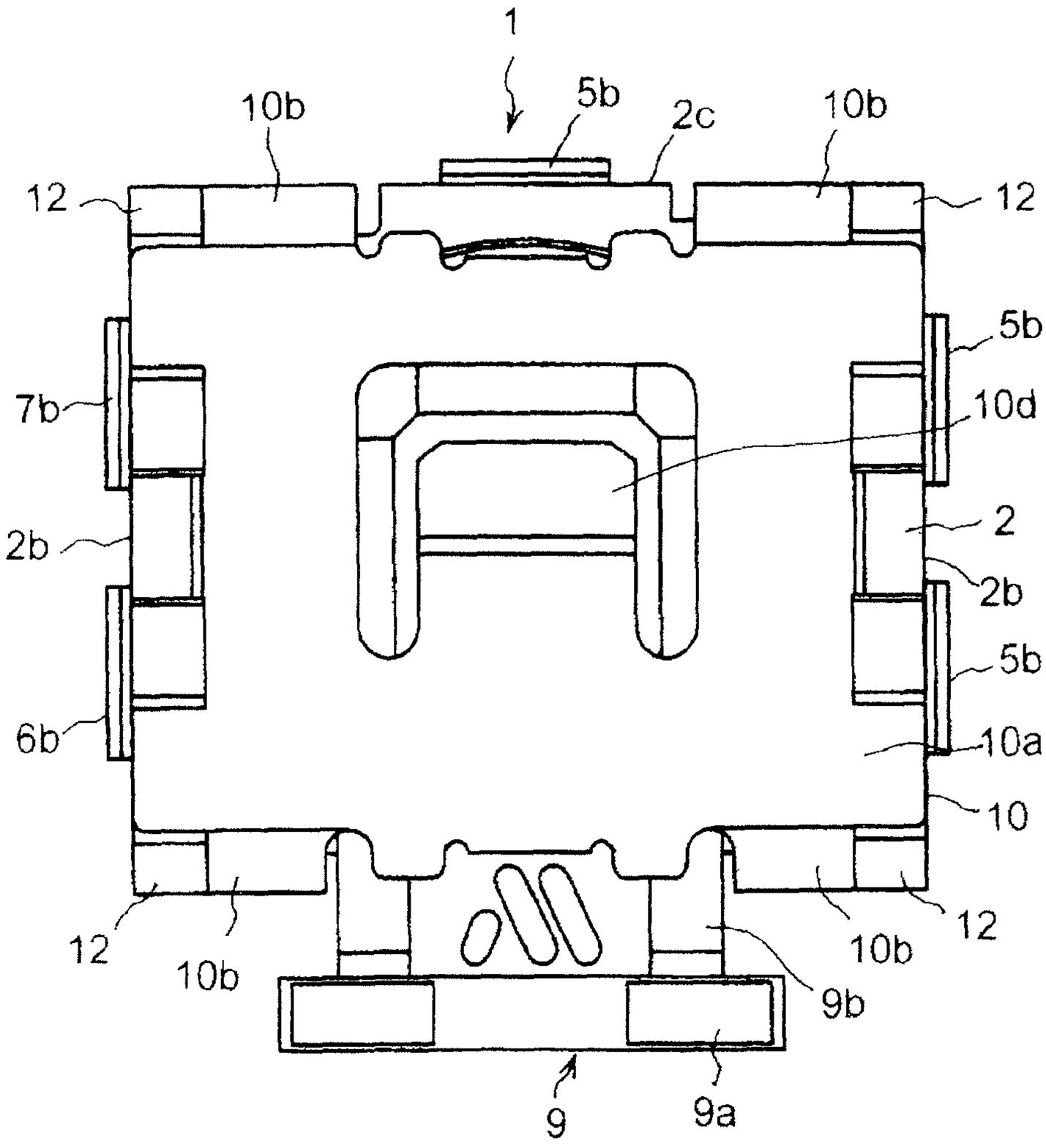

1
10b
5b
2c
10b
12
12
5b
7b
10d
2
2b
2b
5b
6b
10a
10
12
10b
12
10b
9b
9
9a

FIG. 5

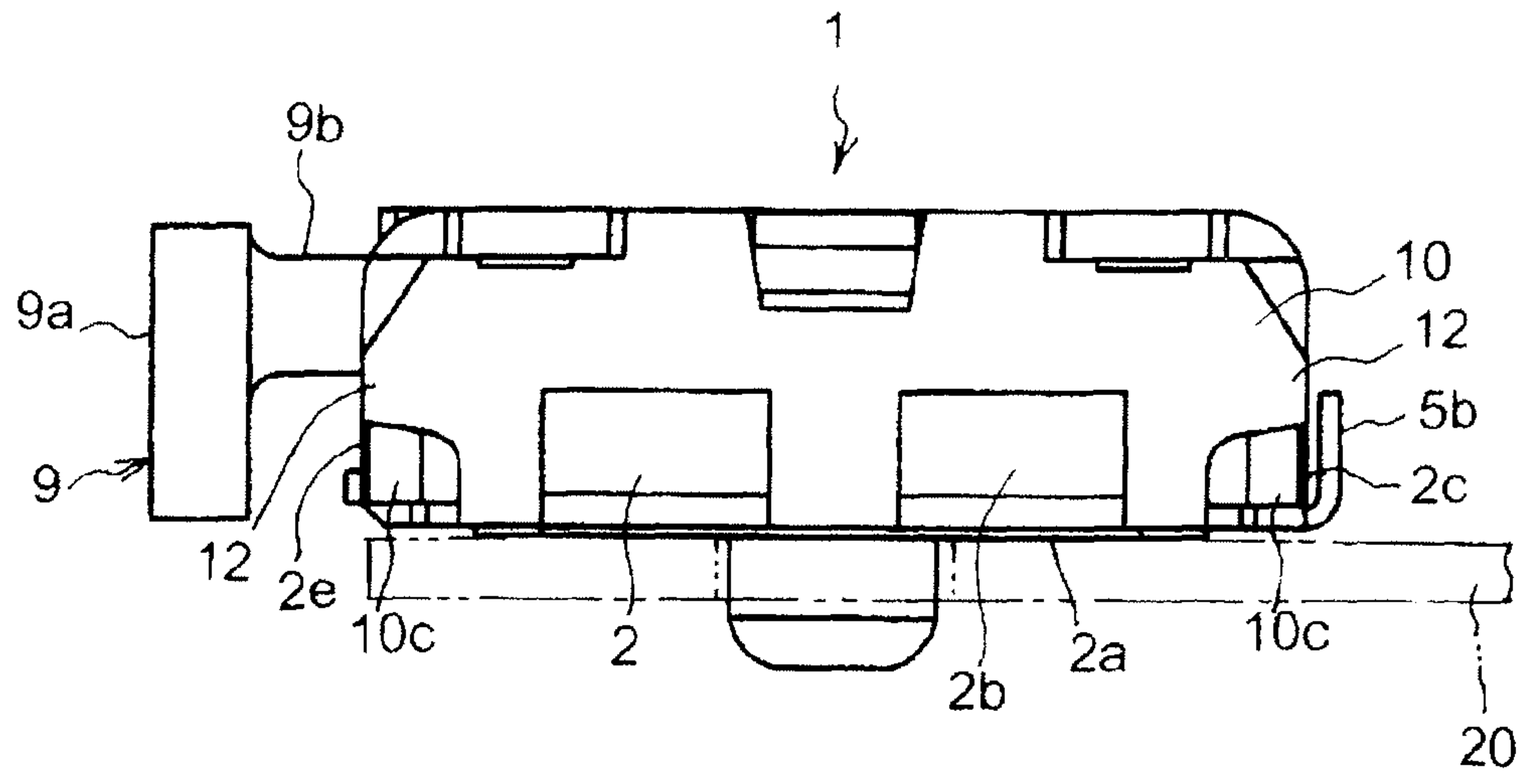

1
9b
9a
9
12
2e
10c
2
2b
2a
10c
10
12
5b
2c
20

FIG. 6

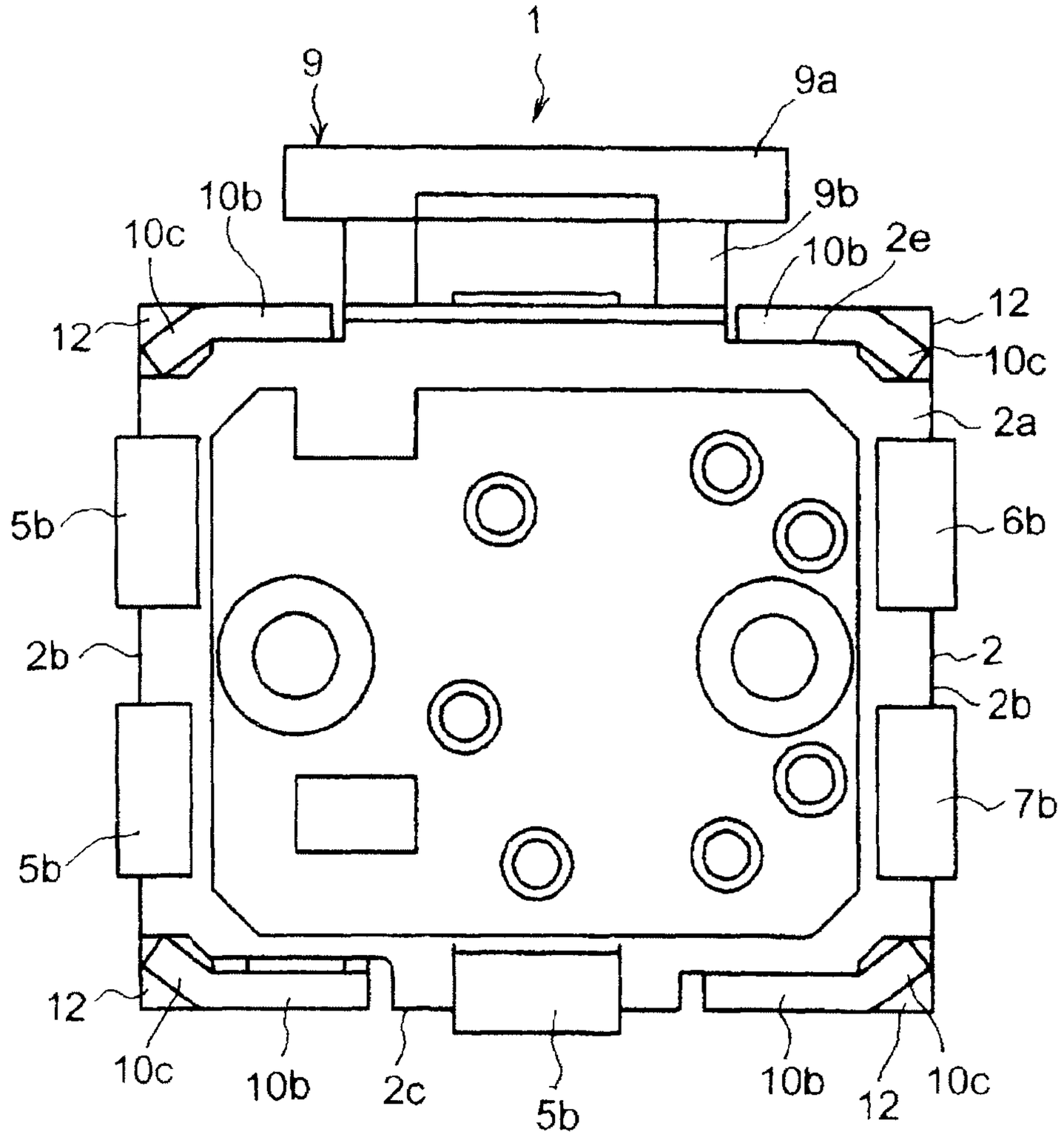

1
9
9a
10b
9b
10c
10b
2e
12
12
10c
2a
5b
6b
2
2b
2b
7b
5b
12
10c
10b
2c
5b
10b
12
10c

FIG. 7

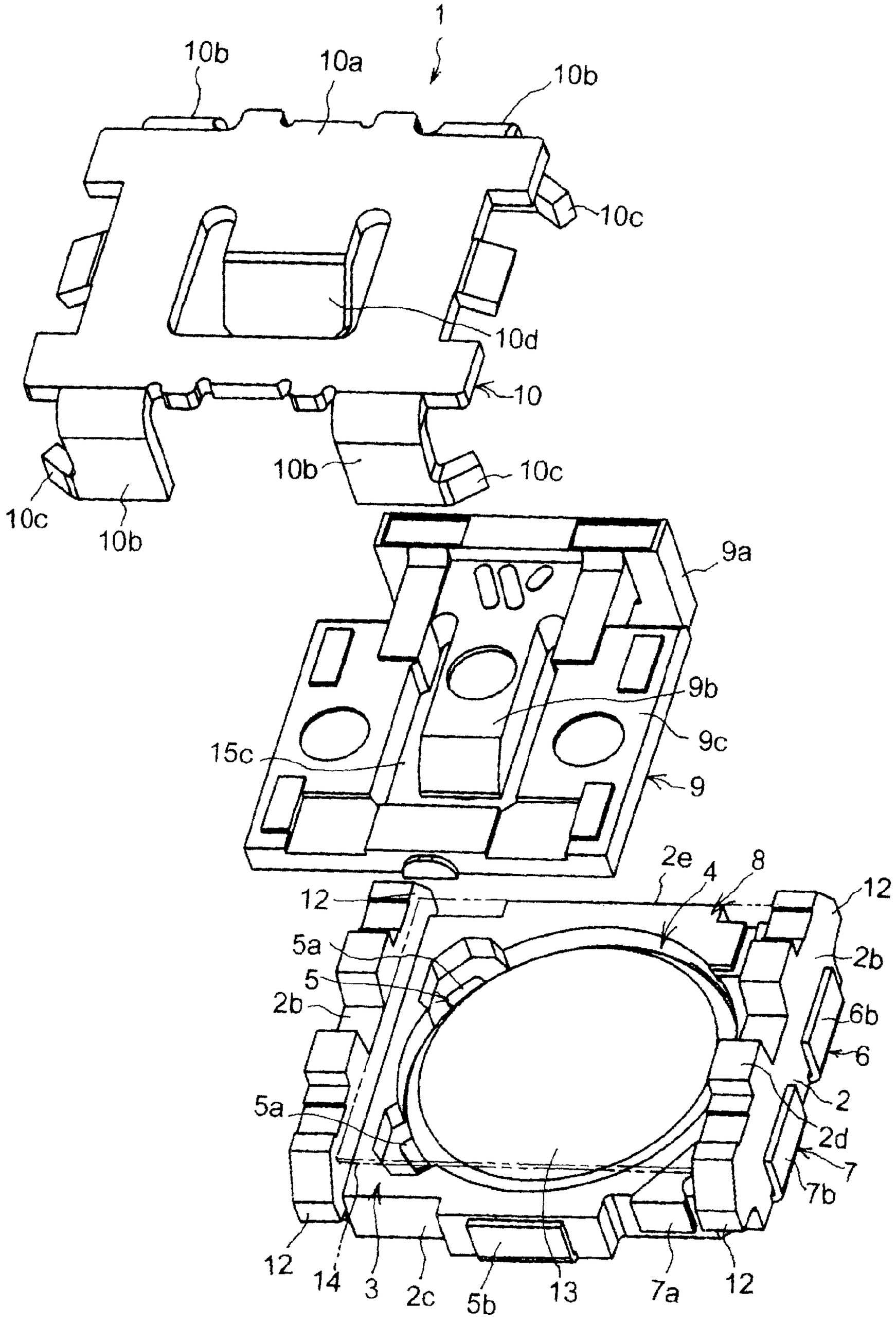

1
10b
10a
10b
10c
10d
10
10b
10c
10c
10b
9a
9b
9c
15c
9
2e
4
8
12
12
5a
5
2b
2b
6b
6
2
5a
2d
7
7b
12
14
3
2c
5b
13
7a
12

FIG. 8

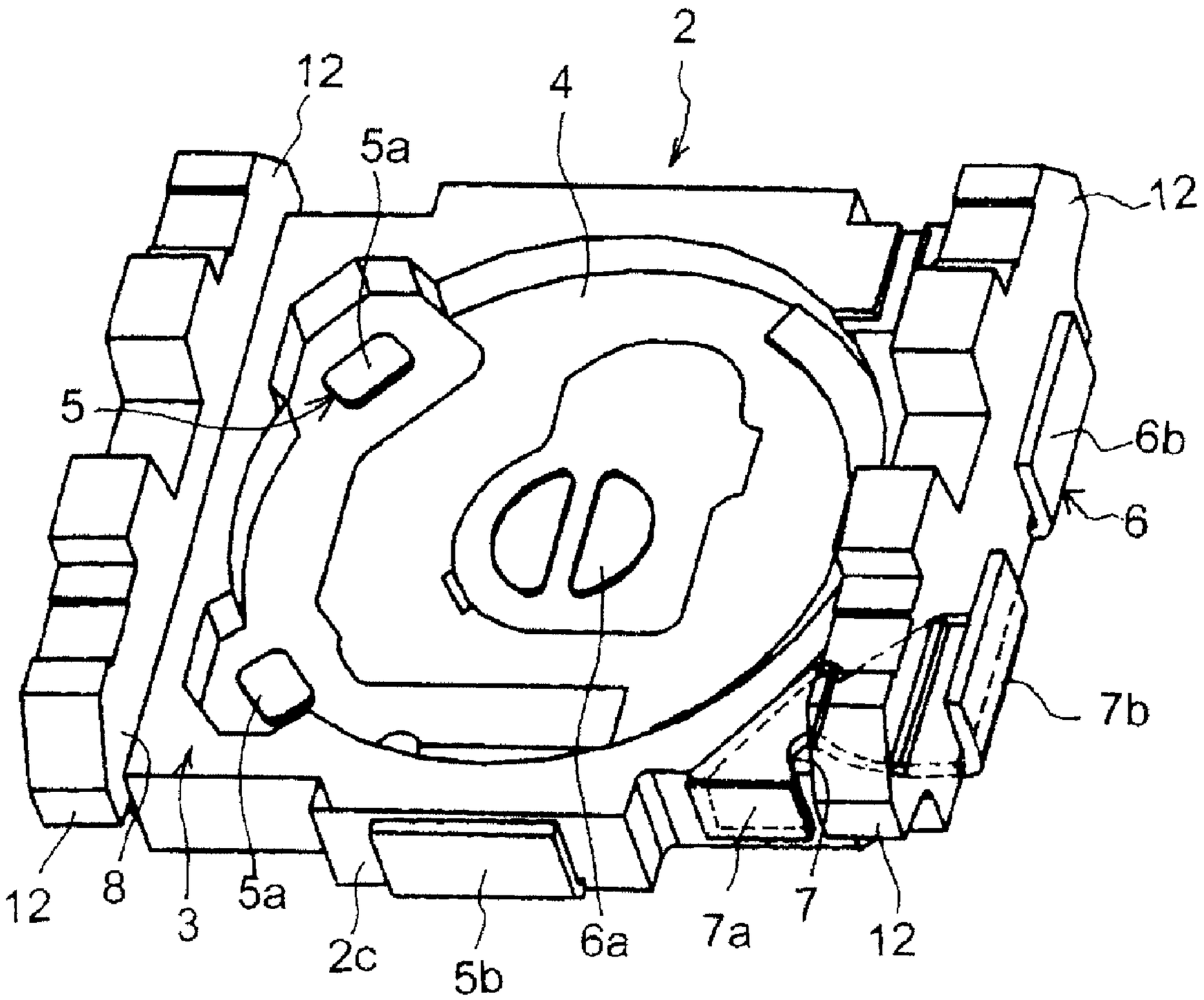


FIG. 9

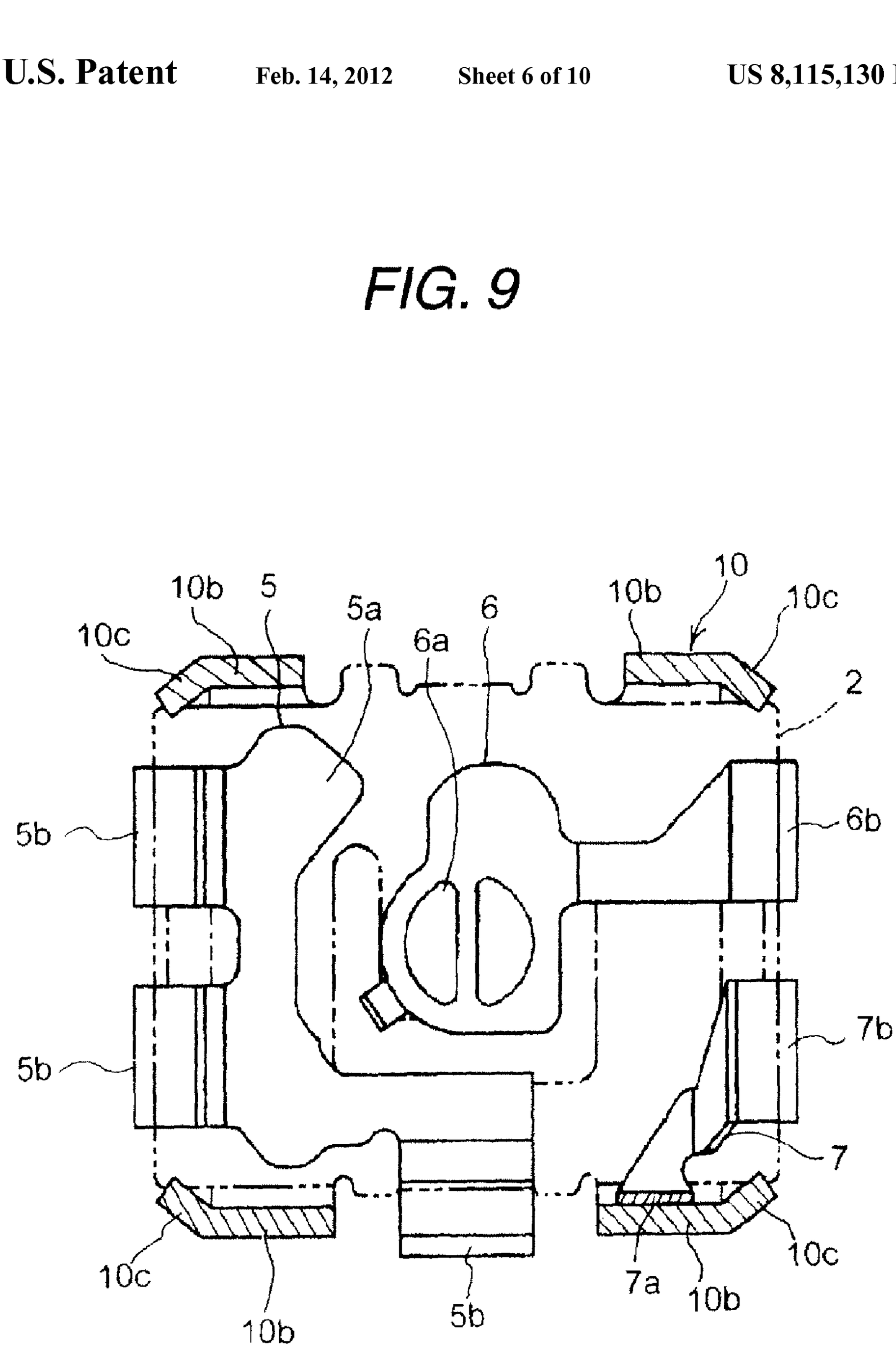


FIG. 10

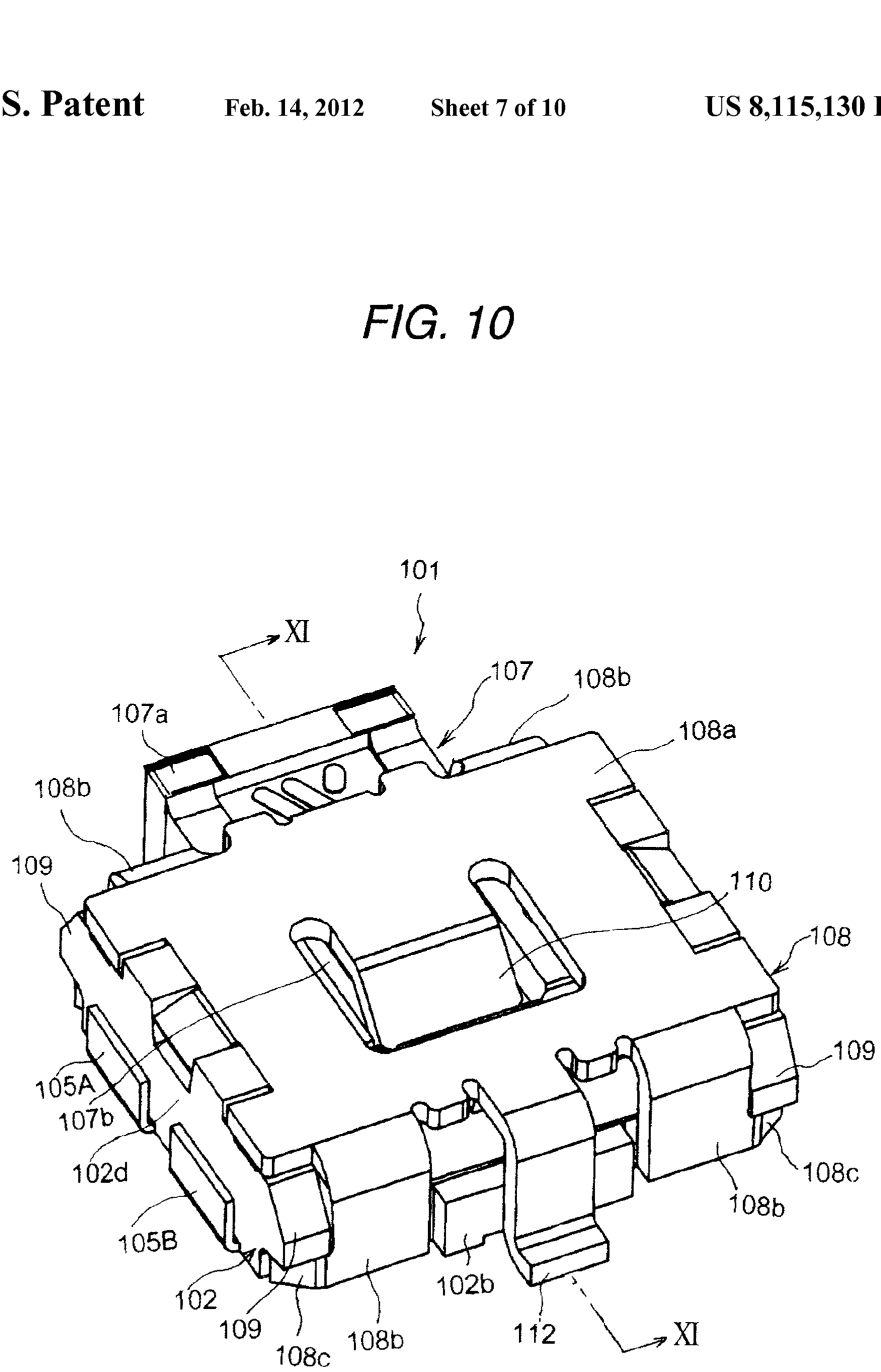

101
XI
107
108b
107a
108a
108b
109
110
108
105A
107b
109
102d
108c
105B
108b
102
102b
109
108b
112
XI

FIG. 11

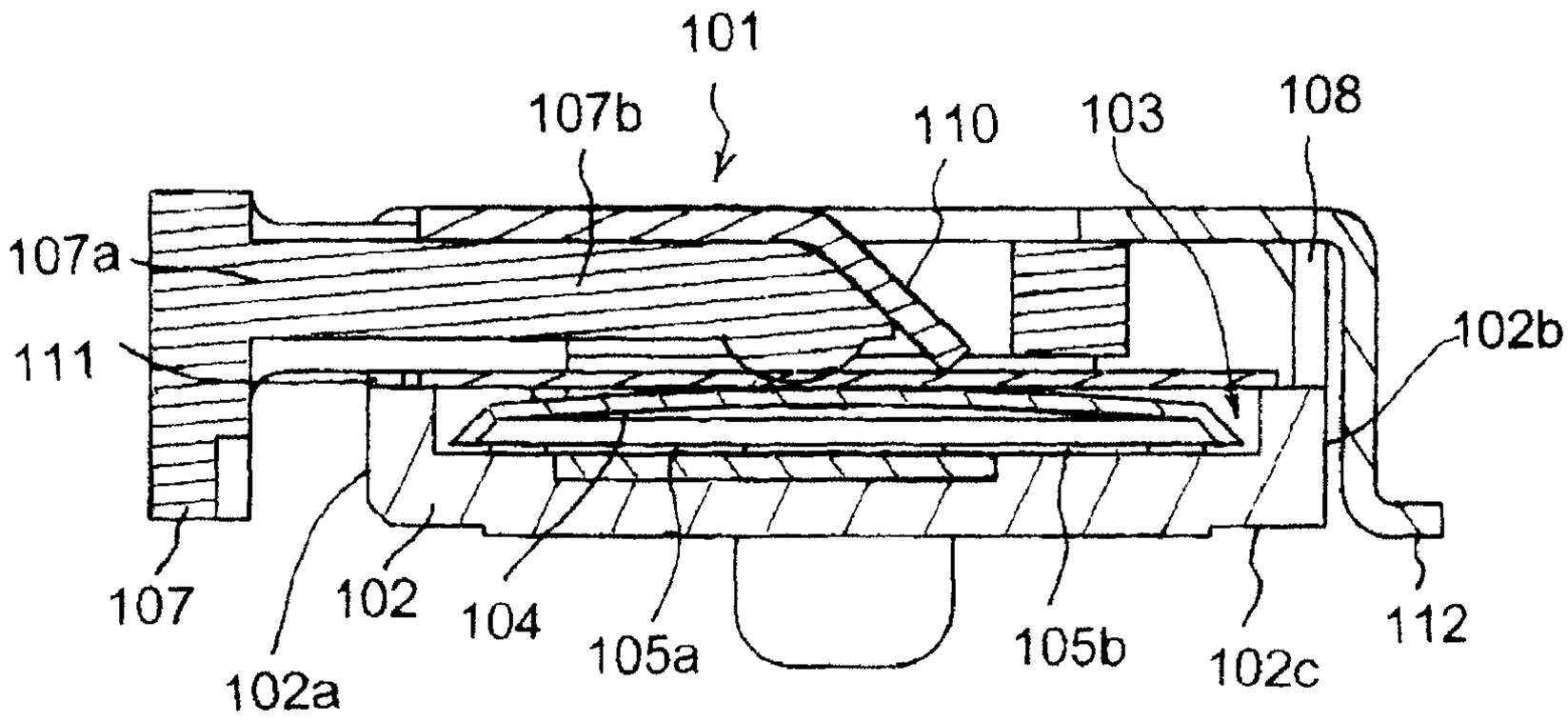

101
107b
110
103
108
107a
111
102b
107
102
104
105a
105b
102c
112
102a

FIG. 12

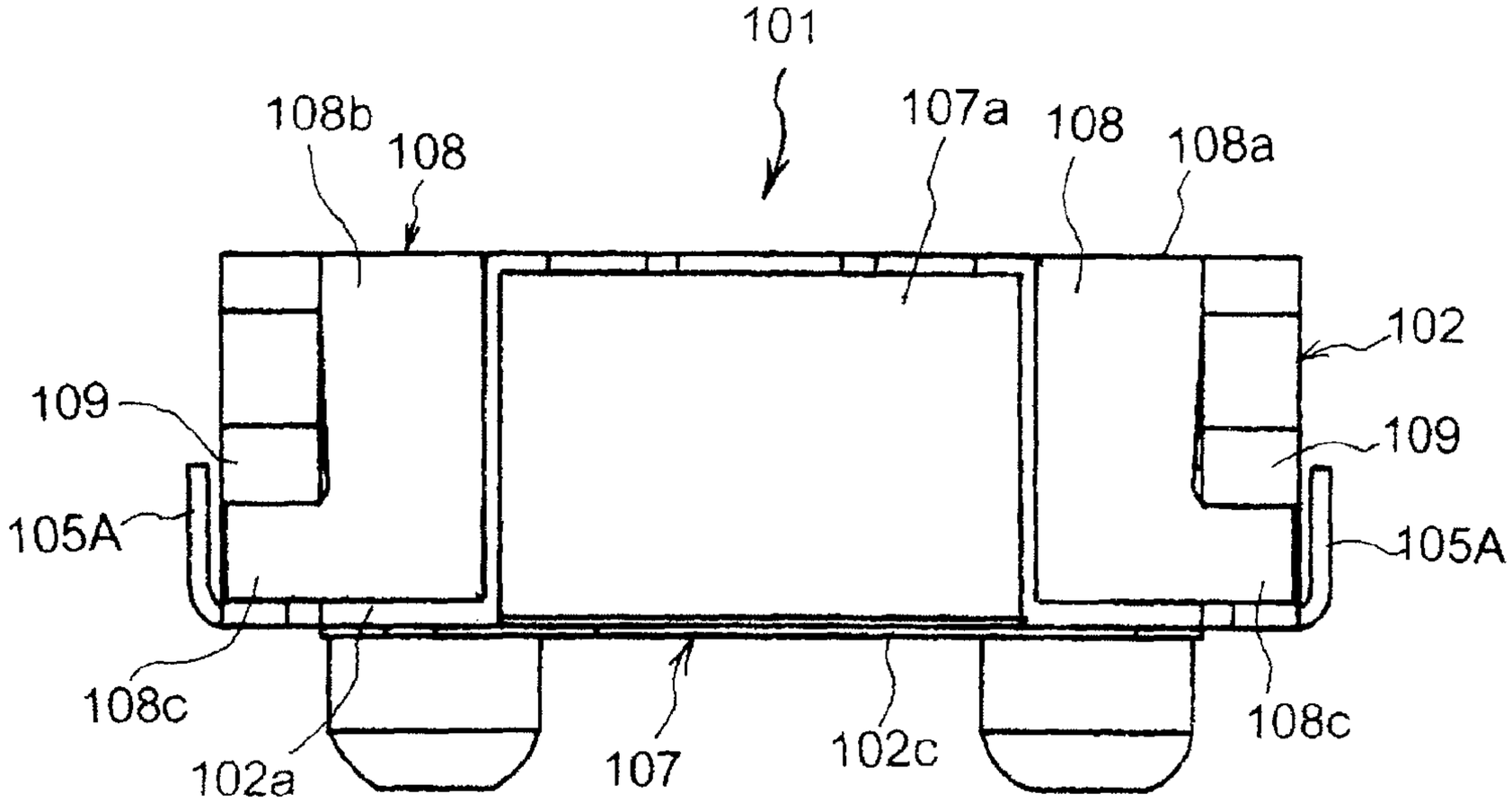

101
108b
108
107a
108
108a
102
109
109
105A
105A
108c
102a
107
102c
108c

FIG. 13

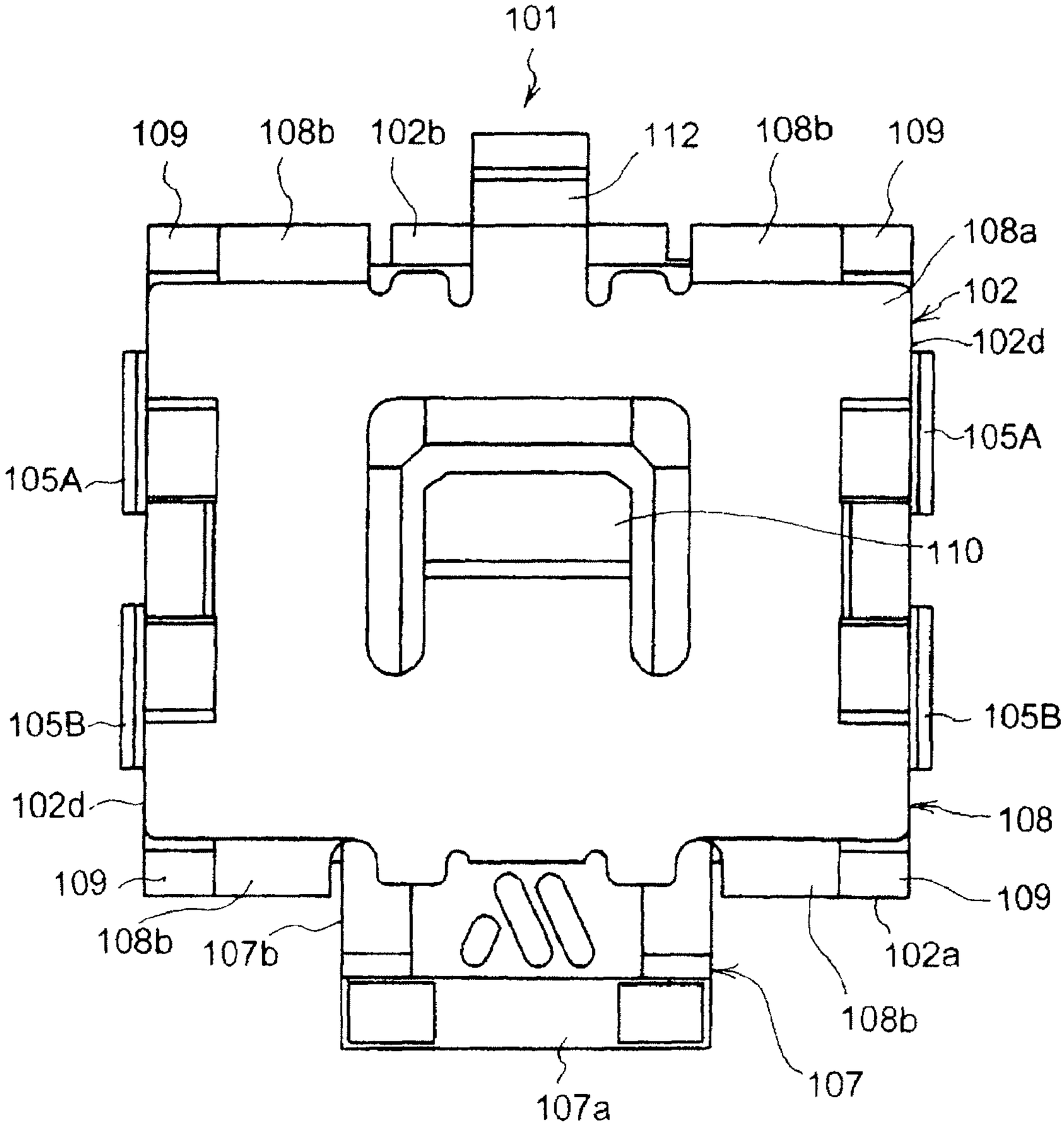
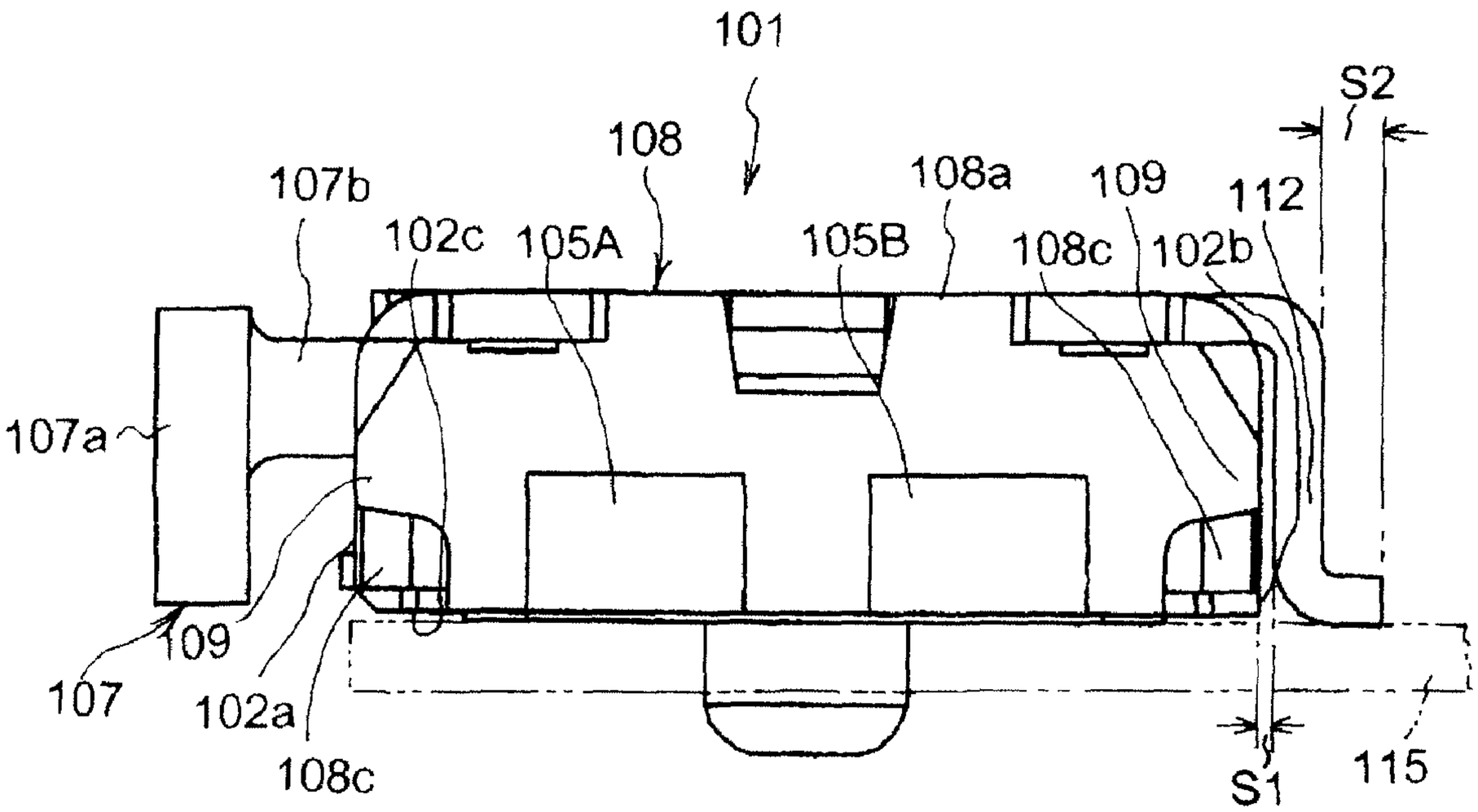

101
109
108b
102b
112
108b
109
108a
102
102d
105A
105A
110
105B
105B
102d
108
109
109
108b
107b
102a
108b
107
107a

FIG. 14


101
S2
108
107b
102c
105A
105B
108a
109
112
108c
102b
107a
109
107
102a
108c
S1
115

ELECTRONIC DEVICE

BACKGROUND

The present invention relates to an electronic device including a switch-type electronic device such as a push switch adapted to be mounted on a printed circuit board to be disposed in various kinds of electronic apparatuses.

There are known various kinds of switch-type electronic devices such as a push switch mounted on a printed circuit board of an electronic apparatus (see, Japanese Patent Publication No. 9-120742 A).

As the conventional switch-type electronic device to which the countermeasure for the static electricity is applied, one example will be described by referring to FIGS. **10** to **14**.

As shown in FIG. **11**, a push switch **101** comprises a box-shaped housing **102** formed with a space **103** an upper side of which is opened. A circular dome-shaped movable contact **104** made of an elastic thin metal plate is disposed on an inner bottom part of the space **103**. A central lower face of the movable contact **104** opposes fixed contacts **105***a* and **105***b* each of which is made of the thin metal plate and fixed on the housing **102** by insertion molding. A protective film **106** is disposed on an upper part of the movable contact **104**, and an operating member **107** made of resin is disposed on the protective film **106**. A cover **108** made of metal is attached to the housing **102** so as to cover the operating member **107** from above.

The housing **102** includes engaging projections **109** respectively protruding outward along a lower face **102***c* of the housing **102** at right and left corners of front and rear side faces **102***a* and **102***b* of the housing **102**. Further, in the other end sides, lead terminals **105**A and **105**B are provided that are directed outward the right and left side faces **102***d* and **102***d* of the housing **102** from the lower face **102***c*.

The operating member **107** includes a pressed part **107***a* and an elastic actuator **107***b*. The pressed part **107***a* extends from a front side face **102***a* of the housing **102** through an opening **111** formed in the front side face **102***a*.

The cover **108** is located on an upper face of the housing **102**. The cover **108** includes an upper plate **108***a* having an inclined piece obliquely extended from a center part thereof toward the inside of the space **103**. A pair of legs **108***a* are extended downward from a front edge of the upper plate **108***a* along the front side face **102***a* of the housing **102**. A pair of legs **108***b* are extended downward from a rear edge of the upper plate **108***a* along a rear side face **102***b*. At a lower end of each of the legs **108***b*, an engagement piece **108***c* is formed so as to oppose a lower face of an associated one of the engagement projections **109**. The engagement pieces **108***c* are bent and caulked so that the cover **108** is retained on the housing **102**.

The pair of right and left legs **108***b* provided in the front side face **102***a* of the housing **102** are separated from each other sufficiently so that at least the operating member **107***b* of the operating member **107** can be translated therebetween.

In the push switch **101** mounted on the printed circuit board **115** in such a way, under a state that the operating member **107** is arranged at a position shown by a dashed chain line in FIG. **11**, when a front end of the pressed part **107***a* is horizontally pressed rearward, the operating member **107** horizontally moves on the protecting film **106** along the upper face of the housing **102** and the end of the operating member **107***b* is directed downward by the inclined piece **110** to apply a push down force to the movable contact **104** located at a lower part.

When the push down force exceeds a prescribed level, as shown by a solid line of FIG. **11**, the lower face of the central part of the movable contact **104** moves downward and comes into contact with the fixed contacts **105***a* and **105***b* to obtain a conductive state (turn-on state) in which the lead terminals **105**A and **105**B are short-circuited through the movable contact **104**. As an amount of pushing operation of the operating member **107**, when the rear face of the pressed part **107***a* abuts against the front side face **102***a* of the housing **102**, a further pushing operation is regulated.

When the operating force of the pressed part **107***a* is released, the movable contact **104** is self-restored to an original attitude to push up the operating member **107***b* and the end of the operating member **107***b* is guided by the inclined piece **110**, so that the operating member **107** is pushed back forward to the position shown by the dashed chain line in FIG. **11** to return to an original non-conductive state (turn-off state).

However, the above-described conventional push switch has a structure that the operating member **107** is continued to be pressed from outside the front side face **102***a* of the housing **102** until the operating member **107** abuts against the front side face **102***a* of the housing **102**. The forces acting on the respective members during in the above pushing operation will be described with reference to FIG. **13**. When the operating member **107** is pushed with a force (a pressing force) P, a pushing up force gradually acts on the cover **108** as the pushing operation proceeds. This force acts on the legs **108***b* as a force (a reaction force) f for pushing the legs **108***b* outward. In such a case, there is a probability that the legs **108***b* and the cover **108** would be deformed to damage a function of the switch.

In these days, downsizing of such a push switch is strongly demanded. The width of each side face of the housing **112** is required to be no greater than 3 mm, and the thickness of the cover **108** is required to be no greater than 0.2 mm. In such a size, the above-described deformation becomes remarkable.

As a countermeasure for preventing the deformation, the thickness or the size of the cover **108** or the width of the leg **108***b* may be increased to ensure the strength of parts. However, contrary to the above-described demand, the size of the push switch is increased.

SUMMARY

It is therefore one advantageous aspect of the present invention to provide an electronic device capable of preventing a cover from being deformed during a pushing operation of an operating member without increasing the size of the electric device.

According to one aspect of the invention, there is provided a switch-type electronic device adapted to be mounted on a circuit board, comprising:

a housing, having:

a first face, adapted to oppose the circuit board; and

a second face, intersecting with the first face and formed with a projection;

a cover, having:

a first part, covering a side of the housing opposite to the first face;

at least one second part, extending from the first part and opposing the second face; and

a third part, extending from each of the at least one second part and engaging with the projection; and

an operating member, having a first part disposed outside the housing and adapted to be operated by a user, and a second part disposed in the housing and configured to switch the

electronic device between a first state and a second state when the first part is operated by the user, wherein:

the first part of the operating member has a portion opposing the second part of the cover, and is configured to abut against the second part of the cover when the electronic device is switched between the first state and the second state.

The switch-type electronic device may be configured such that: the at least one second part includes a pair of second parts; and the second part of the operating member is located between the pair of second parts.

The switch-type electronic device may be configured such that: a thickness of the cover is no greater than 0.2 mm.

According to one aspect of the invention, there is provided a push switch adapted to be mounted on a circuit board, comprising:

a housing, having:

a first face, adapted to oppose the circuit board; and

a second face, intersecting with the first face and formed with a projection;

a cover, having:

a first part, covering a side of the housing opposite to the first face;

at least one second part, extending from the first part and opposing the second face; and

a third part, extending from each of the at least one second part and engaging with the projection;

an operating member, having a first part disposed outside the housing and adapted to be operated by a user, and a second part disposed in the housing;

a movable contact, disposed in the housing and configured to be actuated by the second part of the operating member when the first part of the operating member is operated by the user; and

fixed contacts, disposed in the housing and configured to be electrically connected with each other by way of the movable contact when the movable contact is actuated by the second part of the operating member,

wherein the first part of the operating member has a portion opposing the second part of the cover, and is configured to abut against the second part of the cover when the fixed contacts are electrically connected with each other.

The push switch may be configured such that: the at least one second part includes a pair of second parts; and the second part of the operating member is located between the pair of second parts.

The push switch may be configured such that: a thickness of the cover is no greater than 0.2 mm.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view showing a push switch according to one embodiment of the present invention.

FIG. **2** is a sectional view taken along a line II-II in FIG. **1** and showing a state that an operating member is pushed in.

FIG. **3** is a front view of the push switch.

FIG. **4** is a plan view of the push switch.

FIG. **5** is a side view of the push switch.

FIG. **6** is a bottom view of the push switch.

FIG. **7** is a perspective view of the push switch in a disassembled condition.

FIG. **8** is a perspective view showing a housing of the push switch.

FIG. **9** is a schematic view showing an arrangement of contact members and a cover of the push switch.

FIG. **10** is a perspective view of a conventional push switch.

FIG. **11** is a sectional view taken along a line XI-XI of FIG. **10**.

FIG. **12** is a front view of the conventional push switch.

FIG. **13** is a plan view of the conventional push switch.

FIG. **14** is a side view of the conventional push switch.

DETAILED DESCRIPTION OF EXEMPLIFIED EMBODIMENTS

Exemplified embodiments of the invention are described below in detail with reference to the accompanying drawings.

As shown in FIGS. **1** to **9**, a push switch **1** which is one example of a switch-type electronic device comprises a box-shaped housing **2** made of a resin material and formed with space **3** an upper side of which is opened shown in FIGS. **2**, **7** and **8**. A pair of first contact members **5** and **6** and a second contact member **7** are integrally embedded by an insert molding in an inner bottom part **4** of the space **3**. The pair of first contact members **5** and **6** are made of a metal plate. The second contact member **7** is made of a metal plate. As well as the conventional push switch, the width of each side face of the housing **2** is no greater than 3 mm.

As shown in FIGS. **2**, **7** and **8**, a fixed contact **5***a* is provided on one end of the first contact member **5** and exposed at the inner bottom face **4** of the space **3**. A lead terminal **5***b* is provided on the other end of the first contact member **5** and led out from a lower face **2***a* of the housing **2** so as to extend outward of one of opposite side faces **2***b* of the housing **2**. A fixed contact **6***a* is provided on one end of the first contact member **6** and exposed at the inner bottom face **4** of the space **3**. A lead terminal **6***b* is provided on the other end of the first contact member **6** and led out from the lower face **2***a* so as to extend outward of the other one of the opposite side faces **2***b* of the housing **2**. The first contact member **5** is provided with further lead terminals **5***b* which are led out from the lower face **2***a* so as to extend outward of the rear side face **2***c* of the housing **2**.

An external fixed terminal **7***a* is provided on one end of the second contact member **7** and exposed at a position on the rear side face **2***c* closer to one of the opposite side faces **2***b* (in FIGS. **7** to **9**, the right side face) so as to extend downward from an upper face **2***d* of the housing **2** toward the lower face **2***a*. A lead terminal **7***b* is provided on the other end of the second contact member **7** and led out from the lower face **2***a* so as to extend outward of the one of the opposite side face **2***b* on which the lead terminal **6***b* is disposed.

A front side face **2***e* of the housing **2** is formed with an opening **8** communicating with the space **3**. An operating member **9** includes a pressed part **9***a* and an actuator **9***b* (described later in detail). The operating member **9** is accommodated in the space **3** such that the pressed part **9***a* and a part of the actuator **9***b* extend outward through the opening **8**. At both side end portions of each of the rear side face **2***c* and the front side face **2***e*, there are provided engagement projections **12** to which engagement pieces **10***c* of legs **10***b* provided on a cover **10** (described later in detail) are engaged by caulking.

A dome-shaped movable contact **13** made of a thin metal plate is disposed on above fixed contacts **5***a* and **6***a*. A lower face of a top portion of the dome-shaped movable contact **13** opposes the fixed contact **6***a* across a gap therebetween. An outer peripheral portion of the dome-shaped movable contact **13** is in contact with the fixed contact **5***a*.

A protecting sheet **14** made of an insulating resin sheet material such as polyamide resin is disposed above the movable contact **13**. The peripheral edge part of the protecting sheet **14** is mounted on the upper face of the housing **2** and fixed by adhesive agent so as to cover the space **3** therewith to

prevent dust or foreign materials from entering the conductive members disposed in the space **3**.

As shown in FIG. **7**, the operating member **9** is made of a resin and includes: the pressed part **9***a* which is always to be located outside the housing **2**; the actuator **9***b* extended from the pressed part **9***a* toward inside the space **3**; a slider **9***c* surrounding the actuator **9***b* across a gap **15***c* therebetween. The pressed part **9***a* has parts extended from a front end of the actuator **9***b* upward, downward, rightward and leftward.

The pressed part **9***a* serves as a face receiving an operation for pushing the operating member **9** from the outside of the housing **2**. Further, the pressed part **9***a* serves to prevent the legs **10***b* of the cover **10** located both sides of the opening **8** from being deformed forward. A lateral width of the pressed part **9***a* is, as shown in FIG. **3**, sufficiently greater than a width of each of the legs **10***b*. When the operating member **9** is pushed into the space **3** in the housing **2** and the turn-on state is established (described later in detail), a rear face of the pressed part **9***a* comes in contact with the legs **10***b* so that the pressed part **9***a* covers at least parts of the legs **10***b*, thereby preventing the legs **10***b* from being deformed forward. Alternatively, the rear face of the pressed part **9***a* may come in contact with the front side face **2***e* and may oppose the legs **2***b* across minute gaps therebetween.

The operating member **9** is disposed above the protective sheet **14** so that an abutment part **9***d* which is a free end of the actuator **9***b* opposes an upper face of the top part of the dome-shaped movable contact **13** across the protective sheet **14**. The slider **9***c* is slidably disposed within the space **3**.

The cover **10** is formed by punching and bending a metal plate. The cover **10** includes: a flat upper plate **10***a* attached to an upper part of the housing **2** so as to cover the space **3**; and four legs **10***b* extended from both side portions of each of a front edge and a rear edge of the upper plate **10***a* and bent downward. The engagement piece **10***c* is provided on a tip end of each leg **10***b*. The engagement pieces **10***c* are caulked so as to engage with the lower faces of the engagement projections **12** to retain the cover **10** on the housing **2**. As well as the conventional push switch, the thickness of the cover **10** is no greater than 0.2 mm.

When the cover **10** is attached to the upper part of the housing **2**, one of the legs **10***b* attached on the rear side face **2***c* of the housing **2** comes in contact with the external fixed terminal **7***a* of the second contact member **7** so as to establish electric connection. The contact between the external fixed terminal **7***a* and the leg **10***b* is firmly retained by bending the engagement piece **10***c* of the leg **10***b* toward the housing **2** and caulking to engage with the engagement projection **12**.

An inclined part **10***d* is formed by bending a substantial center part of the upper part of the upper plate **10***a* toward the inside of the space **3** of the housing **2** by about 45 degrees. The inclined part **10***d* is so configured as to abut against the abutment part **9***d* of the actuator **9***b* to bias the actuator **9***b* in a direction pressing the movable contact **13**. When the cover **10** is attached to the upper part of the housing **2**, the inclined part **10***d* is located within the gap **15**. When the pressed part **9***a* is laterally (from front side) pressed, the abutment part **9***d* of the actuator **9***b* comes in contact with the inclined part **10***d* so that the abutment part **9***d* is guided in a direction that the movable contact **13** is pressed (downward perpendicular to the direction that the part **9***a* is pressed). Accordingly, the movable contact **13** is pressed downward and cones in contact with the fixed contacts **5***a* and **6***a*.

In order to assemble the push switch **1**, the movable contact **13**, the protective sheet **14** and the operating member **9** are housed within the space **3** of the housing **2** in this order. Then, the cover **10** is attached to the upper part of the housing **2**. After that, the engagement pieces **10***c* of the legs **10***b* are respectively caulked to engage with the lower faces of the engagement projections **12**.

When the push switch **1** is mounted on the printed circuit board **20**, as shown in FIG. **5**, the operating member **9** is projected forward from the printed circuit board **20**, and the lead terminals **5***b*, **6***b* and **7***b* are soldered with associated wiring parts. In this condition, the second contact member **7** is connected to a wiring part of the earth circuit on the printed circuit board **20** by way of the lead terminal **7***b*. Also the cover **10** is connected to the wiring part of the earth circuit by way of the second contact member **7**.

There will be described how to operate the above-described push switch **1** with reference to FIG. **2**.

First, under an initial condition shown by dashed chain lines, the abutment part **9***d* of the operating member **9***b* is in contact with the upper face of the top part of the dome-shaped movable contact **13** across the protecting sheet **14**. In accordance with a synergism of elastic urging force of the movable contact **13** directed upward and the inclined face of the inclined part **10***d*, the operating member **9** is urged leftward in this figure (in an opposite direction to the direction that the pressed part **9***a* is pressed), thereby the pressed part **9***a* is projected outward (forward) from the housing **2**. Incidentally, the outer peripheral portion of the movable contact **13** is in contact with the fixed contact **5***a* but the lower face of the top part of the dome-shaped movable contact **13** is away from the fixed terminal **6***a*, so that the push switch **1** is placed in the turn-off state.

From this state, when the pressed part **9***a* is pressed rightward in this figure, the abutment part **9***d* of the operating member **9***b* is guided downward (perpendicular to the direction that the pressed part **9***a* is pressed) along the inclined part **10***d* of the cover **10**, and presses the upper face of the top part of the dome-shaped movable contact **13** through the protecting sheet **14**. Accordingly, the movable contact **13** is moved downward and the lower face of the top part thereof comes into contact with the fixed contact **6***a*. As a result, the fixed contacts **5***a* and **6***a* are electrically connected, and the push switch **1** is placed in the turn-of state.

When the operating member **9** is pushed into the space **3** of the housing **2** and the fixed contacts **5***a* and **6***a* are electrically connected, the rear face of the pressed part **9***a* comes in contact with the legs **10***b* and the pressed part **9***a* covers at least parts of the legs **10***b* in order to prevent the legs **10***b* from being deformed forward thereby the engagement pieces **10***c* are disengaged from the engagement projections **12**. With this configuration, the strength of the cover **10** can be eventually increased without increasing the width and thickness of the cover **10** and the legs **10***b*. As a result, downsizing of the push switch can be attained.

The rear face of the pressed part **9***a* may not come in contact with the legs **10***b* but may be configured to be stopped at such a position that the rear face of the pressed part **9***a* opposes the legs **10***b* across such a minute gap that the deformed legs **10***b* immediately comes in contact with the rear face.

From the state, when the pressing against to the pressed part **9***a* is canceled, the movable contact **13** moves upward due to the own elastic restoration force and the push switch **1** is placed in the turn-off state. In accordance with the urging force generated by the restoring action, the abutment part **9***d* of the actuator **9***b* is guided leftward in this figure (the opposite direction to the direction that the pressed part **9***a* is pressed) along the inclined part **10***d*, so that the pressed part **9***a* moves forward and returns to the original condition.

When the finger of a person who operates the push switch **1** mounted on the printed circuit board **20** installed in an

electric apparatus pushes a front face of the pressed part **9***a*, static electricity carried by the person may be of the operator is supplied to the operating member **9** through the finger. However, the supplied static electricity is transferred to the earth circuit on the printed circuit board **20** by way of the cover **10** and the second contact member **7**.

It is to be noted that although the above described embodiment is a preferable embodiment of the invention, the invention is not limited to this embodiment, but various modifications can be made within a scope not deviating from a gist of the invention.

The present invention is applicable to a switch-type electronic device other than the push switch and an electronic device other than the switch-type electronic device as long as it is adapted to be mounted on a circuit board by soldering.

The material of the housing **2** is not limited to resin as long as it is insulative. The material of cover **10**, the first contact members **5**, **6** and the second contact member **7** is not limited to metal as long as they are conductive.

The lead terminal **7***b* may not be exposed at one of the opposite side face **2***b* but may be exposed at the front side face **2***e*.

What is claimed is:

1. A switch-type electronic device adapted to be mounted on a circuit board, comprising:

a housing, having:

a first face, adapted to oppose the circuit board; and

a second face, intersecting with the first face and formed with a projection;

a cover, having:

a first part, covering a side of the housing opposite to the first face;

at least one second part, extending from the first part and opposing the second face; and

a third part, extending from each of the at least one second part and engaging with the projection; and

an operating member, having a first part disposed outside the housing and adapted to be operated by a user, and a second part disposed in the housing and configured to switch the electronic device between a first state and a second state when the first part is operated by the user, wherein:

the first part of the operating member has a portion opposing the second part of the cover, and is configured to abut against the second part of the cover so as to prevent the second part of the cover being deformed outward when the electronic device is switched between the first state and the second state.

2. The switch-type electronic device as set forth in claim **1**, wherein:

the at least one second part includes a pair of second parts; and

the second part of the operating member is located between the pair of second parts.

3. The switch-type electronic device as set forth in claim **1**, wherein:

a thickness of the cover is no greater than 0.2 mm.

4. A push switch adapted to be mounted on a circuit board, comprising:

a housing, having:

a first face, adapted to oppose the circuit board; and

a second face, intersecting with the first face and formed with a projection;

a cover, having:

a first part, covering a side of the housing opposite to the first face;

at least one second part, extending from the first part and opposing the second face; and

a third part, extending from each of the at least one second part and engaging with the projection;

an operating member, having a first part disposed outside the housing and adapted to be operated by a user, and a second part disposed in the housing;

a movable contact, disposed in the housing and configured to be actuated by the second part of the operating member when the first part of the operating member is operated by the user; and

fixed contacts, disposed in the housing and configured to be electrically connected with each other by way of the movable contact when the movable contact is actuated by the second part of the operating member,

wherein the first part of the operating member has a portion opposing the second part of the cover, and is configured to abut against the second part of the cover so as to prevent the second part of the cover being deformed outward when the fixed contacts are electrically connected with each other.

5. The push switch as set forth in claim **4**, wherein:

the at least one second part includes a pair of second parts; and

the second part of the operating member is located between the pair of second parts.

6. The push switch as set forth in claim **4**, wherein:

a thickness of the cover is no greater than 0.2 mm.

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